conditions which hold for much of the year under the control of a local indraft of surface air through the Golden Gate and across San Francisco Bay.

The campus of the University of California lies at the foot of the Berkeley Hills, which overlook the bay. The instrumental exposures at the meteorological station range from 300 to 325 feet above sealevel. On the east rise the hills to altitudes of 1,500 to 1,900 feet within a mile and a half to 2 miles, and on the west a smoothly sloping plain falls away to the bay some two miles distant. The topography favors dynamic warming of air which crosses the hills from an easterly direction and is forced to descend the slopes toward the bay. Easterly winds are not common at Berkeley. For their occurrence, a dominant area of high barometric pressure over the Cordilleran region with gradients sloping westward and southwestward toward the Pacific, is necessary. Under these conditions, rarely in summer and occasionally in winter, the persistent westerly and southwesterly wind at Berkeley is fully reversed and an offshore wind produced. The length of time during which this reversal may hold is variable in the extreme, and depends on a delicate adjustment of atmospheric conditions the details of which are, as yet, too obscure for discussion.

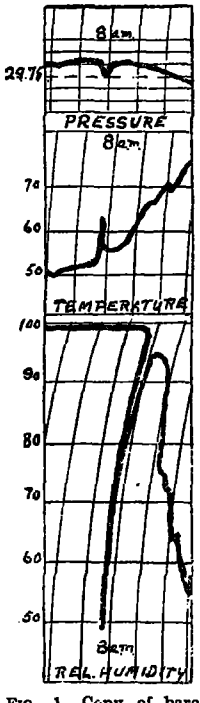

FIG. 1.—Copy of barogram, thermogram, and hygrogram recorded at University of California, Nov. 2, 1917, showing abrupt changes due to temporary prevalence of an easterly wind at Berkeley.

This easterly surface current, occurring at Berkeley more frequently in winter, apparently differs in its origin from an upper current occurring in the San Francisco Bay region in summer, and noted by McAdie as follows:[1]

> Kite experiments indicate that at the 1,000-meter (3,280-foot) level on summer afternoons there is a moderately strong flow of air from east to west. It would seem as if the heated air of the Great Valley, or some portion of it, moved seaward above the level of the incoming or eastward flow of the surface draught.

The surface current occurs chiefly when the continent has prevailingly high pressures as contrasted with the low pressures of the oceanic area, while the upper current occurs when the continent is prevailingly under low pressure and the oceanic area high pressure.

A striking example of a very short lived easterly wind occurred in the early forenoon of November 2, 1917. Atmospheric pressures over Nevada and Arizona on that morning were high (30.00 inches in central Nevada), and the winds over the California coast were mainly offshore and moderate. At San Francisco, however, the 5 a. m. [8 a. m. 75th meridian time] observation at the local office of the Weather Bureau indicated moderate westerly winds. At Berkeley up to about 7:30 a. m. the winds were also westerly and moderate. Between 7:30 a. m. and 8:00 a. m. the prevailing easterly wind dominating the Pacific slope overcame the westerly wind at Berkeley. The abrupt change in the atmospheric conditions is shown in the accompanying traces of the autographic records made at the meteorological station. (See fig. 1.) As a result of warmth of the descending air, in part dynamically produced, the temperature rose 12 degrees in less than that number of minutes. The pressure dropped nearly 0.10 inch when the relatively warm and therefore lighter air from the hills took the place of the cooler, heavier air from the ocean. The relative humidity dropped from very near the saturation point to less than 50 per cent so suddenly that the time occupied can not be judged from the trace. The easterly wind blew for something less than half an hour, and the recovery of all the curves was very rapid. The rapid diurnal rise of temperature and the fall of relative humidity, characteristic of fine weather at this station, would have begun at about the time when conditions were suddenly interrupted by the wind from the hills. There is evidence that this is the case, in the fact that both temperature and humidity curves returned, not to the values they represented before the interruption, but to values approximating those which would have obtained in the uninterrupted diurnal curve.

[1] *McAdie, A. G.:* The rainfall of California. Univ. Cal., Publ. geog., Feb. 19, 1914, 1: 145.

551.578.7 (782)

NEBRASKA HAILSTORM OF AUGUST 8, 1917.

By GEORGE A. LOVELAND, Meteorologist.

[Dated: Weather Bureau Office, Lincoln, Nebr., Nov. 20, 1917.]

During the spring and early summer local storms of greater or less severity may reasonably be expected in that portion of the United States lying east of the Rocky Mountains. Such storms consist of wind, rain, and *sometimes hail.*

Hail is a very interesting phenomenon in connection with these storms, though occasionally terrifying and destructive. From a study of the rather incomplete hail records of the Nebraska Section Center of the Weather Bureau, it is found that out of a possible 100 per cent hail probability during the four months, May, June, July, and August, 33 per cent of the hail would occur in June, 23 per cent in May and July each, and 21 per cent in August.

What is doubtless one of the most remarkable hailstorms on record is that which occurred in southeastern Nebraska on August 8, 1917—remarkable in the unusual length and breadth of the area covered, the great amount of damage done to crops and property, the large size of the individual hailstones, and the enormous quantity of hail that fell.

From reports of cooperative observers, conversations with citizens in the hail district, newspaper accounts of the storm, and from a personal visit by the writer three days later to a portion of the devastated district, the course and duration of the storm has been quite accurately defined (see fig. 1), it has been possible to make a somewhat correct estimate of the damage done, and many interesting and unusual facts have been brought out.

The storm traveled from a point in Merrick County north of Central City to the Kansas line south of Wymore, in Gage County, a distance of approximately 92 miles in length, and over a width of 4, 8, or even 12 miles, as variously reported. In hailstorms recorded in the past the length is usually less than 50 miles and the width but 1 or 2 miles.

The writer has been unable to obtain any actual measurements of the hailstones in this storm, but the common description was "as large as hen's eggs," or "as big as your fist," or, most common of all, "the size of baseballs." In one house in York the hail blew in through a wire screen, a glass windowpane, and a thick cloth shade which happened to be down, and an hour later the owner of the house found a hailstone on the bed, and according to her testimony it was then the

size of a hen's egg, and around it was a good-sized damp spot from the melted ice. The marks on the sides of houses showed the large size of the hail, and were so close together there was not room to put one's fingers between them. High up in a window on the north side of the Burlington Railway station at York was a smooth, round hole about 2 inches in diameter. As this was under the eaves, which projected 4 or 5 feet over the sidewalk, the wind must have come rather horizontally and with great force to cut such a neat, round hole.

The quantity of hail which fell was enormous. Observers say that during the storm they were not able to see 10 yards. Drifts of hail 3 to 5 feet high were found in protected places. Photographs taken shortly afterwards show the ground white with hail like a 1 or 2 inch fall of snow in winter. In an orchard near Exeter hailstones and apples which had been knocked off lay on the ground thickly, and were practically the same size, so that in the photograph it is difficult to distinguish which are apples and which hailstones. At Swanton, the day after the storm, a drift 1 foot high was piled up against a building; and at Bradshaw hail was still visible on Friday, two days after the storm.

According to the testimony of the people the wind velocity varied in different localities. Around Polk there was a light wind, while at York the velocity was considerable. Large hailstones were blown through the north windows of the hotel there, and some rolled along the second-floor corridor a distance of 70 feet and thence down the stairs to the office below. In private houses the hail was blown from one side clear through to the other. At Exeter the wind was still more severe. The tops of trees ere badly damaged, the ground being strewn with branches; roofs were blown off, and windmills and smaller farm buildings tipped over.

The property loss was considerable. Throughout the hail-beaten district windows on the north side of buildings were shattered; many costly art-glass windows in the churches were destroyed, and business blocks, hotels, private residences, and farmhouses were more or less damaged by broken glass; skylights, tin roofs, and shingles were everywhere injured, and in many places the siding of houses and window casings were cracked and split as if hit with a sledge hammer. In York the tile roof of the new Federal building was so badly shattered that three sides of it had to be relaid. In Exeter and Friend the windows were broken and siding injured on the west side of buildings as well as on the north, for in that section the wind came from the west and northwest.

Hundreds of chickens were killed; young pigs and calves were fatally injured; horses and cattle in pasture away from shelter were so pounded and bruised that they were covered with blood and huge lumps; rabbits were killed by the score in the fields, and one farmer picked up 400 dead grackles—crow blackbirds—in a space about 300 by 300 feet.

Fruit and shade trees were badly stripped of leaves and fruit, and even the branches had the bark torn off in places; garden truck was completely destroyed, and sweet corn was completely ruined. Fodder corn, cane, and millet were badly damaged, and prairie hay land was stripped of its grass, which was washed down and piled against the fences.

Fortunately all small grain had been harvested, but the corn crop over the entire area of the storm—225,000 acres of corn affected—was probably damaged 50 per cent.

The writer passed through a portion of the devastated region the latter part of October, and learned that the corn ears that were pounded by the hail did not develop enough to pay for the trouble of husking. Some farmers had turned their stock in to eat what was left in the fields, and others had cut it up for ensilage and stored it away in silos. Some people replanted their gardens, and successfully raised a few vegetables before the killing frost of October 8. Residences all through the devastated district had been reshingled and newly painted; downspouts and gutters had been mended; glass replaced, and the dead leaves and fallen branches cleared away, so that but little trace of the terrible storm was left.

PRECEDING WEATHER CONDITIONS.

A study of the weather conditions preceding this hailstorm shows that a cyclonic area of considerable energy passed eastward to Iowa on the night of August 6–7, and was accompanied by substantial rains in Kansas, eastern Nebraska, Iowa, and Minnesota. Two minor disturbances followed this LOW—one centered in the northern and one in the southern part of the United States. On the morning of the 8th these disturbances were connected by a trough of moderately low pressure, which extended from New Mexico northeastward across western Kansas and central Nebraska to Minnesota. An area of high pressure of considerable energy, 30.4 inches, moved rapidly southeastward from the extreme north along the eastern slope of the Rocky Mountains, and on the morning of the 8th was centered in Montana, but extended over Wyoming, the Dakotas, and northwestern Nebraska. This HIGH continued its course southeastward, and on the morning of the 9th had extended over most of Nebraska, Kansas, Iowa, and Minnesota, with its center at 30.4 inches in western South Dakota.

This hailstorm appears not to have been of the usual type. The temperature was not specially high at the earth's surface; on the contrary the maximum temperatures on the 8th in the region where the hail occurred and in all of eastern Nebraska, were slightly below normal. They ran as follows: York, 83°F.; Pawnee City, 85°; Falls City, 88°; Hebron, 85°; Fairmont, 80°; and Grand Island, 86°. The average maximum temperature at Lincoln on that date is 87°, and may fairly be taken as an index to the average maximum temperature for the region under discussion.

Many people noticed the unusual appearance of the clouds before the hail began. One observer in York described them by saying that there was a greenish cloud in the southwest and another in the northwest, greenish also, but much darker, and that they seemed to be coming together, while in the center were masses of smaller lighter clouds rolling over and over and tumbling about with great violence. She spoke of the queer roar and crackling which preceded the hail, "like marbles knocking together in the sky." Then followed the terrific roar of the hail itself as it fell upon the tin roof of the store. Voices could not be heard and the noise of the bombardment was beyond description. An observer at Friend, and many elsewhere, mentioned the greenish clouds and reported that before the storm it was quite warm, with a south-southwest wind; that there was just a little hail at first; then a lull, after which the wind turned suddenly to the north and the hail came with a rush. The largest-

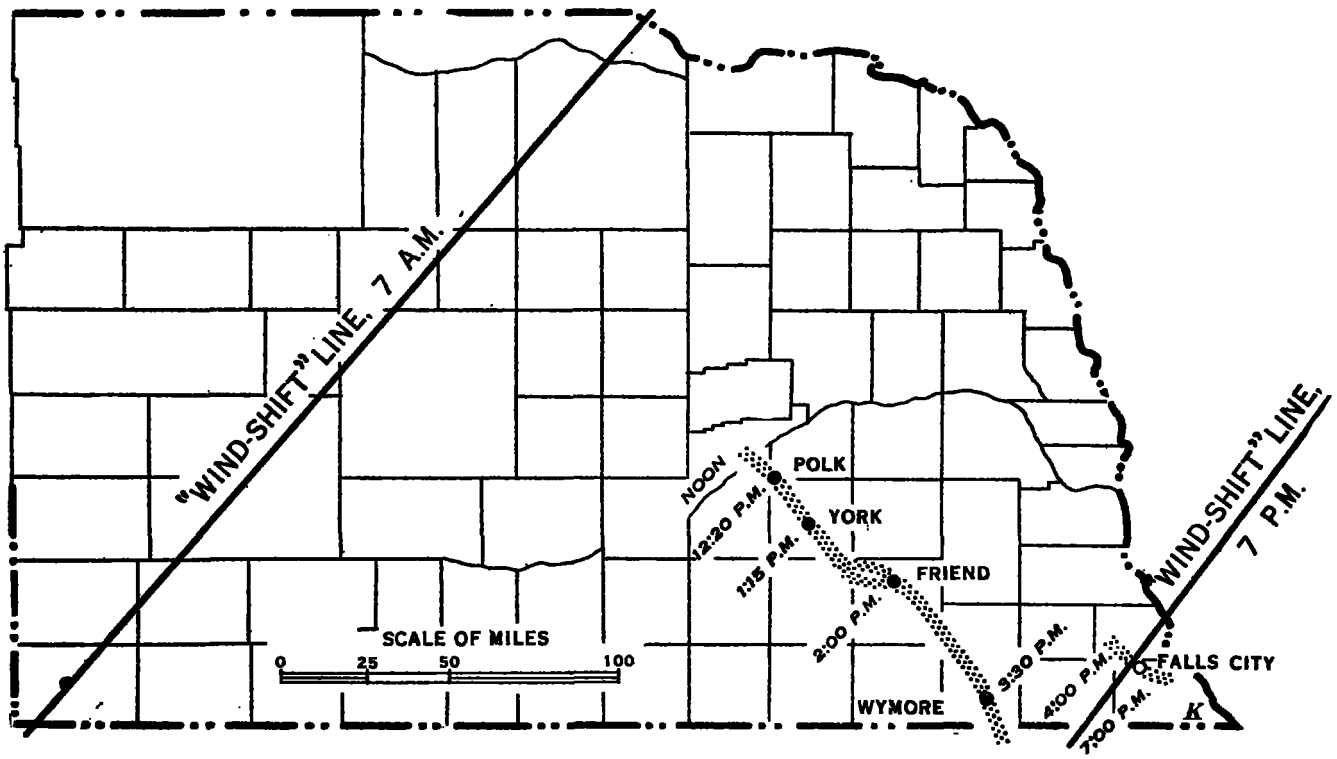

FIG. 1.—Map of eastern Nebraska, showing path of the destructive hailstorm of Aug. 8, 1917, with times of arrival at successive points.

sized hail fell immediately after the change in the wind, followed by smaller hail which fell in enormous quantities for 10 minutes or 15 minutes. Some rain accompanied the hail and continued falling for some time after the hail stopped. The total precipitation exceeded 1.00 inch (water) over most of the storm area.

The storm path is shown in figure 1 from the point of first occurrence in Merrick County, north of Central City, about noon, southeastward, progressing at the rate of about 25 miles an hour, until it reached northern Kansas at about 4 p. m. The writer believes that as the trough of low pressure shown on the weather map of August 8, 7 a. m. (Central Time), passed eastward, the hail came with the shift of wind upon the advent of the energetic HIGH closely following the trough of moderately low pressure. This trough extended across the State from southwest to northeast and the "wind-shift" line reached the northernmost points of the hail region first. The hail was propagated southward along the advancing line of contact between the cool and the warm air currents which was revealed by the violent commotion in the clouds noticed by observers. These conditions moved eastward with the general cyclonic area of which they were a part, resulting in the southeasterly trend of the hail path, and were not, as many people supposed, a definite cloud mass or small cyclonic area eight or ten miles wide moving in a southeasterly direction.

It is common for summer thunderstorms in Nebraska to occur along the "wind-shift" line in a trough of low pressure as outlined for this hailstorm. As this trough passed over Nebraska the rainfall was light, except in connection with the hailstorms. Similar conditions developed in other parts of this trough. Small severe hailstorms were reported in Kansas, and one 13 miles in length in Nemaha and Richardson Counties, Nebr. The latter reached Falls City at 7 p. m. just as the trough of low pressure passed, and the wind shifted to the north on the advent of the HIGH.

VAPOR PRESSURE OF ICE.[1]

551.57:
551.467

By S. WEBER.

(*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §978.)

The object of these experiments was to investigate the vapor pressure of ice at very low temperatures and to obtain, if possible, new foundations for the truth of formulas showing the dependence of vapor pressure on temperature. The principal difficulty in such measurements is the fact that at very low temperatures the vapor pressure becomes extremely small, e. g.:

Temperature, °C.	Vapor pressure of ice. mm. of Hg.
0	4. 579
−25	0. 480
−63	0. 003
−98	0. 000015

and previous results are not to be relied on below 60° C. [−60° C?.] A statistical method was adopted, the pressure being measured by an absolute manometer, which was sensitive to a difference of pressure of 0.001 dyne/cm², and a Wollaston hot-wire manometer. Special care was taken to have the necessary correction for thermomolecular pressure as small as possible. Control measurements were made with a mercury manometer, temperatures being registered by a platinum-resistance thermometer. The water used was obtained partly by repeated distillation, partly by synthesis.

Experiments were conducted at temperatures from −22° to −193° C. The results were placed in a number of tables and are found to agree very well with the vapor-pressure formula due to Nernst:

$$\log p(\text{mm.Hg}) = -2611.7/T + 1.75 \log T - 0.00210\,T + 6.5343.$$

—*T.B[arratt]*.

[1] Kongl. danske vidensk. selskabs forh., 1916, p. 459. Ztschr. f. Instrumentenk., Beibl. Mar. 1, 1917, 5:41–43.